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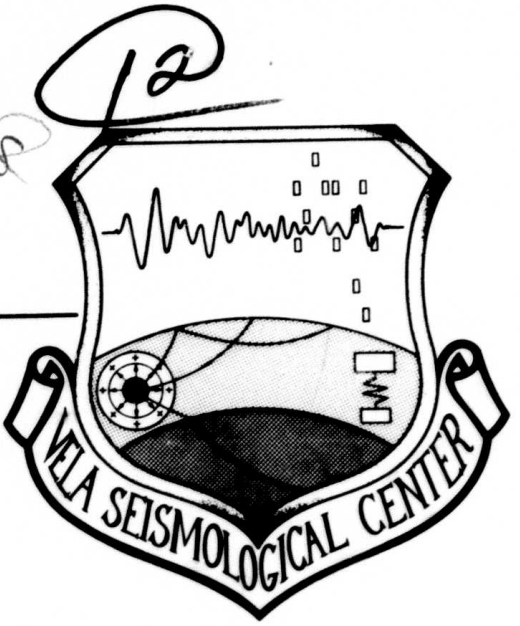
VSC-TR-81-13

SEISMIC DATA ANALYSIS CENTER FINAL REPORT



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22 JUNE 81

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The operation and maintenance of the Seismic Data Analysis Center (SDAC) are summarized for the contract year beginning 1 October 1978 and ending 30 September 1979. Reported are the statistics relating to computer usage; information relating to the maintenance, programming, data services, data availability; and the effort to expand the research systems at the facility.

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SEISMIC DATA ANALYSIS CENTER FINAL REPORT

SEISMIC DATA ANALYSIS CENTER REPORT NO.: SDAC-TR-80-1

AFTAC Project Authorization No.:	VELA T/9706/B/PMP
Project Title	Seismic Data Analysis Center
ARPA Order No.:	2551
Name of Contractor:	TELEDYNE GEOTECH
Contract No.:	F08606-79-C-0006
Date of Contract:	01 October 1978
Amount of Contract	$1,868,984
Contract Expiration Date:	30 September 1979
Project Manager:	Robert R. Blandford (703) 836-3882

P.O. Box 334, Alexandria, Virginia 22314

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ABSTRACT

The operation and maintenance of the Seismic Data Analysis Center (SDAC) are summarized for the contract year beginning 1 October 1978 and ending 30 September 1979. Reported are the statistics relating to computer usage; information relating to the maintenance, programming, data services, data availability; and the effort to expand the research systems at the facility.

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I. INTRODUCTION

This final report summarizes the operation and maintenance of the computer systems at the Seismic Data Analysis Center (SDAC) in Alexandria, Virginia. The work performed to augment and expand the online and research systems is also reported. Other activities, such as facility improvements, demonstrations, operations, and data services are also discussed.

Chapter II is a consolidation of the statistics relating to the usage and reliability of the real-time and batch processor systems. It also tabulates the data that has been analyzed and reported in our Seismic Event Bulletin and sent to the mass store. Chapter III reviews the programming activities for all of the systems except the recently acquired PDP-11/70. Chapter IV details the maintenance performed during the year and discusses some of the important equipment malfunctions. The activities of data services and the institutions and agencies receiving data from the SDAC are given in Chapter V. Chapter VI discusses the development of a system to receive real-time data from a prototype seismic station and the effort expended on the PDP-11/70. The facility changes to increase the controlled areas are given in Chapter VII. Finally, a system used for the Seismic Data Collection System was acquired for analog to digital conversion use at SDAC. The installation and programming of this system are described in Chapter VIII.

Facility Overview

At the conclusion of the contract, the major computer systems consisted of an IBM 360/44, two IBM 360/40's, a DEC PDP-15/50, a DEC PDP-11/70, a Communication Processor, and a DEC PDP-11/35 to support the routine analysis of seismic data. Some of these systems are shown in the photograph as Figure I. Figure II is a photograph of the system used by the analyst to produce the daily bulletin.

Real-time data were received from NORSAR, Alaska, Pinedale Wyoming, Albuquerque New Mexico, and the prototype NSS system located in Tennessee. These data were used in bulletin preparation and augmented with data from the United Kingdom, the Yellow Knife Array, the Canadian Network, and selected stations reported by the National Earthquake Information Service. Data services routinely accepted and catalogued data from 13 SRO/ASRO sites, KSRS, and for a limited time, ILPA.

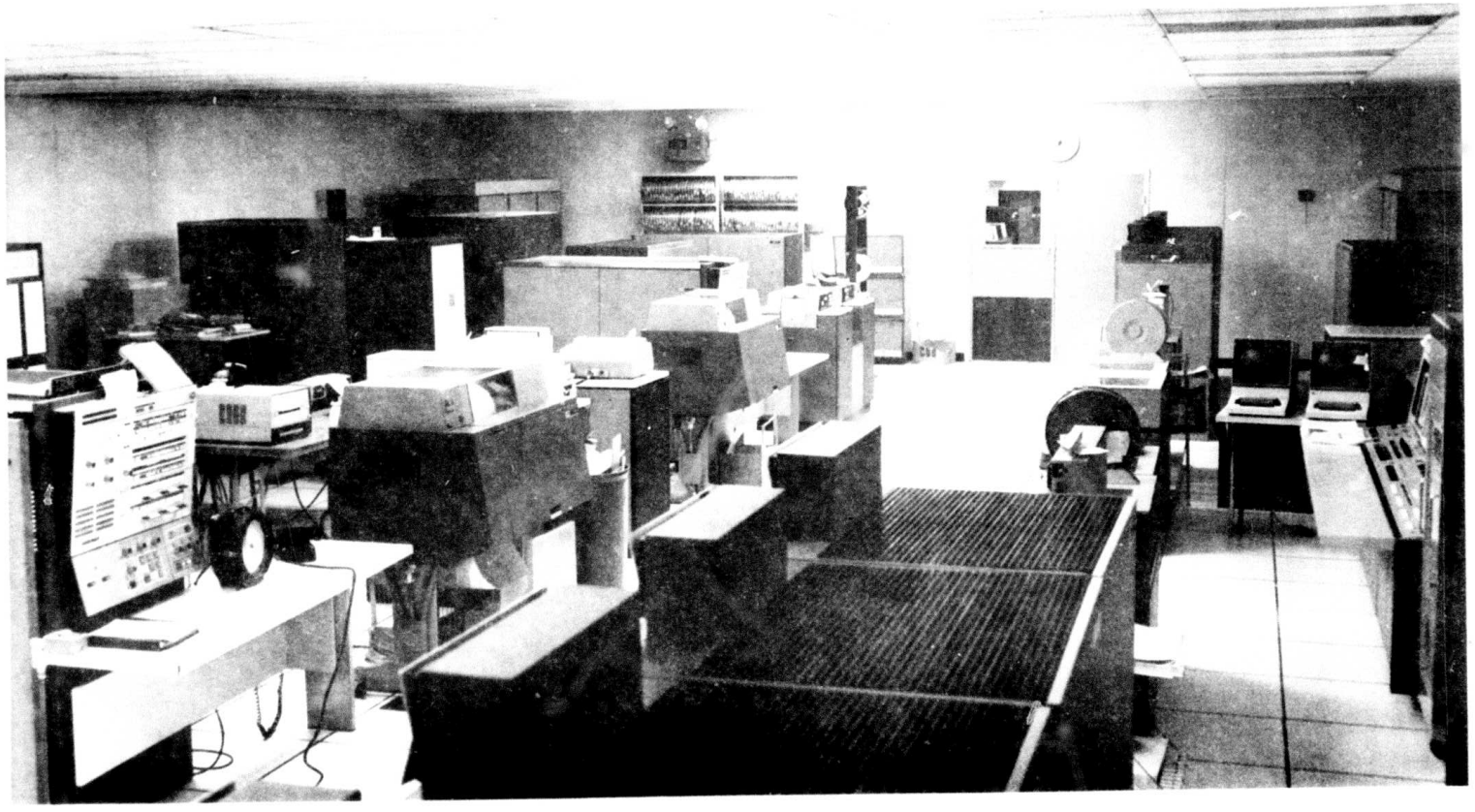


Figure 1. SDAC Computer Facility

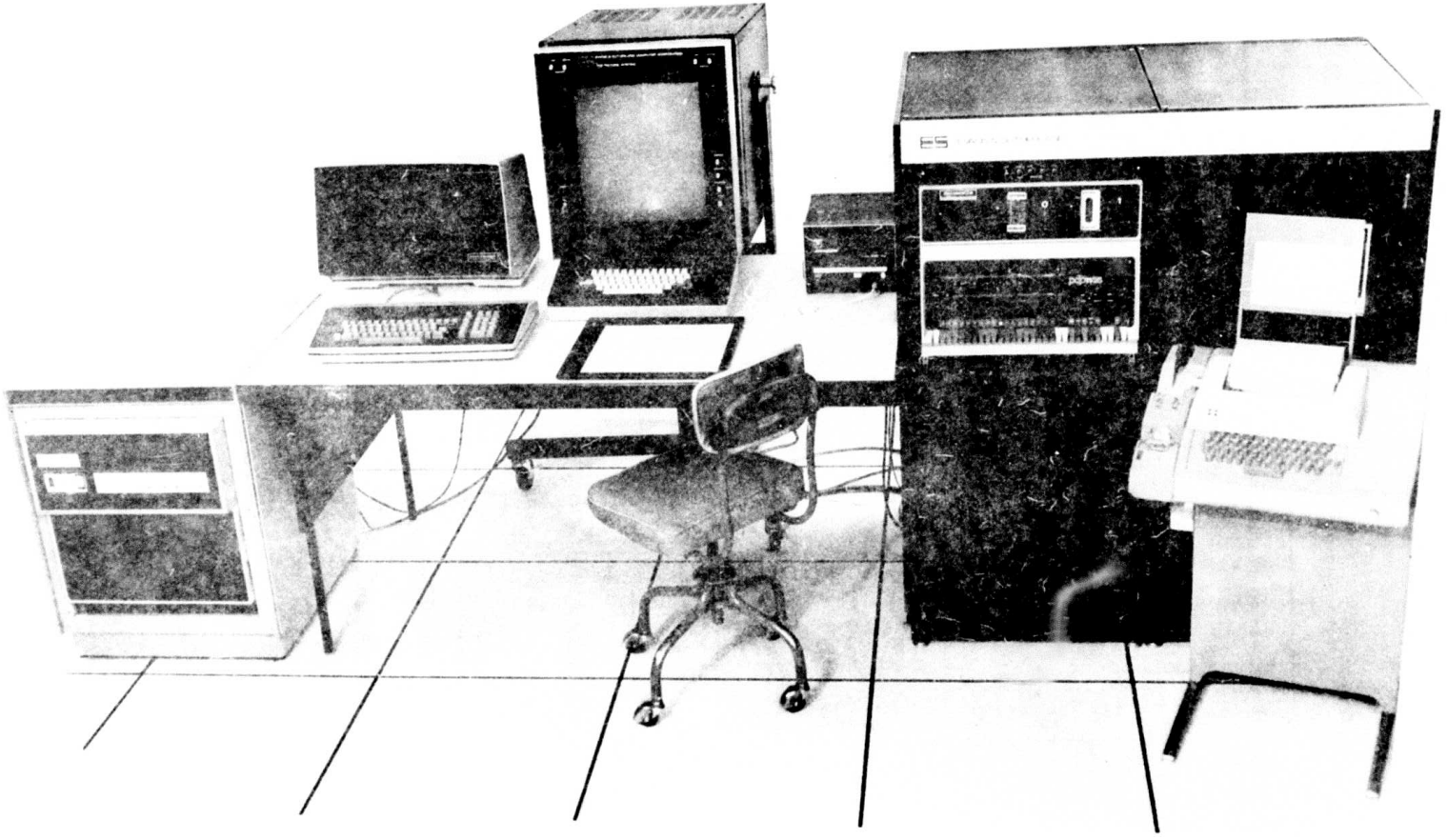


Figure 2. Analyst Station

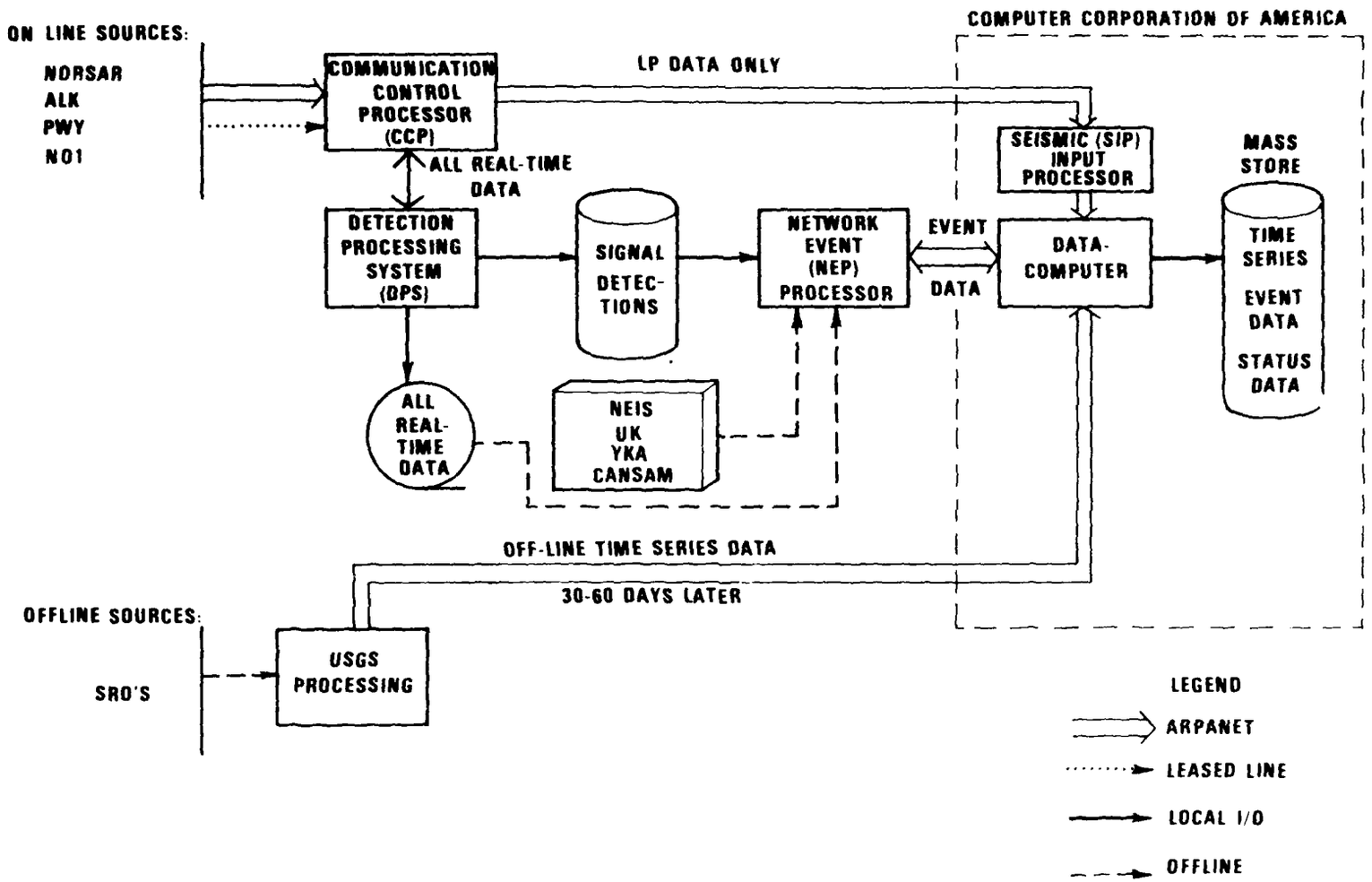


Figure 3. Data Flow

The IBM 360/44 is used as a batch processor. It supports the bulk of the research efforts and is used extensively by data services. The DEC PDP-15/50 is considered an interactive processor. It is used as a "stand alone" system by investigators. The system allows the user to view waveforms on a display screen to determine the quality of the data and perform processes such as filtering, spectra, and signal measurements.

The remaining systems are used to gather, analyze, and store the real-time and early reporting data. The functions performed by these systems are depicted in Figure 3. The upper left corner of the figure shows the real-time data stream from the Norwegian Seismic Array (NORSAR), Alaska (ALK), Pinedale (PWY), and an experimental site in Tennessee (NO1). These data go into the Communications and Control Processor (CCP) where they are formatted for subsequent processing and are monitored by the operators for data and transmission quality. Most of the long-period data (one sample/second) are sent in real-time to the Data Computer operated by the Computer Corporation of America (CCA) in Boston, Massachusetts, where they are recorded on a Mass Storage device. All of the data, short-period, long-period, waveform segments, and status information are also routed to the Detection Processing System (DPS).

The DPS records this data stream on standard magnetic tape and performs detections on selected short-period data channels and records them on a disk shared with the Network Event Processor (NEP) and on the same data tape as the real-time data. With these functions accomplished, the real-time portion of the system ends.

The NEP system is used for the routine analysis. Its inputs consist of the detections recorded on the shared disk by the DPS, the tapes containing the waveforms recorded by the DPS, and, after about 10 days, data reported by other agencies. This external data consists of signal start time picks by other analysts and detection lists from other automatic detectors. These data sources include the National Earthquake Information Services (NEIS), the United Kingdom (UK), the Yellowknife Array (YKA), and the Canadian Network (CANSAM). The analyst reviews the alphanumeric arrival information and the waveforms recorded by the DPS to determine the locations, depths, and origin times of the various events causing the signals. The analyst interacts with the data and has the ability to manipulate the waveforms by scrolling in time, overlaying traces on each other, apply filters, and automatically measure

start times and amplitudes from a graphics display. At the conclusion of his work a file is created containing the events he has formed, the data associated to the events with the results of the event location calculations (distance, azimuth, residuals, etc.) and other arrival data not correlated to a specific source. This file is also sent to CCA and archived for future use.

After about a three month delay, all of the data from the Seismic Research Observatories (SRO's) that have been received by the United States Geological Survey (USGS) are sent to CCA and merged into the event files created by the analyst. The SRO data consists of waveform segments of detections from SP channels and continuous LP data.

The resulting files can then be accessed by authorized users on the ARPANET. Not shown in this figure is the DEC PDP-11/70 which is the SDAC ARPANET connection. Researchers and investigators wanting the seismic files at CCA would use the DEC 11/70 for such data requests.

The program activities on the real-time systems dealt mostly with program changes caused by reconfiguring the real-time data input data. Programming effort was also devoted to increasing the efficiency and reliability of the code by removing references to LASA. Experiments on the detector were performed that required software support. Changes to the input data stream also required programming efforts on the batch systems. Programs were also established to support the VELA link with other data sources.

Data services created several data sets and provided data or information to 38 agencies, institutions, or contractors.

Although very little hardware was added to the facility under this contract, significant software effort was expended on the DEC PDP-11/70 and a processor to input data from a new site.

The highlight of the year was a visit by a delegation of scientists and engineers from the United Kingdom and the Soviet Union. Their visit was prompted by the consideration of installing seismic sites within the USSR. Their U.S. tour included visits to Lincoln Labs, the Sandia Corporation in Albuquerque, the prototype site in Tennessee, and finally the SDAC. The

briefings at this facility included conferences describing the online SDAC systems and demonstrations of the NEP and mass store retrieval systems. The news media were present and the visit was publicized on the NBC Evening News.

Authority

This work was performed for contract number F08606-79-C-0006. The project was authorized by VT/9706/B/PMP. This report is submitted in accordance with data item 010A2 of the contract.

II. OPERATIONS

The computer systems at the SDAC are operated in several ways. An IBM 360/44 computer is used by the scientist in a batch mode of operation. Jobs are run using either remote terminals or by submitting card decks. A DEC PDP-15/50 is used interactively. Seismic traces are displayed on a video terminal and the researcher verifies the data and performs some time series analysis functions. The real-time data recording and analysis systems are also supported by operations. These systems are operated continuously and monitored for correctness and availability of data, reliability of communication lines, and operating conditions of the CCP, DPS, and NEP systems.

All systems have routine maintenance performed and require some degree of repair. Significant malfunction occurred in the interfaces between the 360/40B (NEP) and the PDP-11/35, in the 360/44 to the CCP, and in the PDP-11/70 to the ARPANET. The interface problem between the 360/40B and PDP-11/35 was not corrected; its error rate is marginally acceptable for routine use. The other interface errors were corrected.

About 95 hours of downtime on the 360/44 were caused by a voltage fluctuation in the power to the 360/44. This problem was very elusive and required numerous specialists from IBM field service to locate. The problem subsided and eventually went away without a known correction being made.

Downtime on the 11/70 amounted to 270 hours. The cause was the failure of several major components. Most of this 11/70 system is maintained under vendor contract. Difficulty in obtaining spare parts and people familiar with the system caused the excessive delay.

Statistics concerning the operation of the systems are tabulated in this chapter. Tables I and II show that the CCP and DPS operated continuously 97% of the contract year. Table III gives NEP utilization. Table IV gives 360/44 utilization in number of runs per user. Table V shows the distribution of 360/44 block time by operating system. Table VI gives ENSCO's computer usage for the contract period, PDP-11/70 usage is given in Table VII. Preparation of the seismic bulletin continued. Figure 4 shows the data sent to the mass store.

TABLE I
CCP Downtimes

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
System Crashes	06:15	08:17	04:11	03:51	00:48	02:22	01:03	06:46	01:44	02:20	01:21	01:14	40:12
P/M	08:49	16:50	18:02	-	01:20	03:13	02:28	02:48	01:20	05:31	-	01:04	61:25
Investigating	00:04	00:38	00:58	00:11	00:10	00:05	00:04	00:44	00:58	-	-	00:09	04:01
Operations	01:52	02:11	-	02:22	00:38	-	00:53	-	00:21	03:02	-	-	11:19
Testing	11:01	11:21	07:34	11:52	04:09	37:49	09:52	07:07	01:11	02:57	08:04	03:03	116:00
Power Failures	-	-	-	-	-	-	-	-	00:30	-	-	-	00:30
Total Possible Recording Hours	744	720	744	744	672	744	720	744	720	744	744	720	87:60
Total Hours of Recording	715:59	680:43	713:15	725:44	664:55	700:31	705:40	726:35	713:56	730:10	734:35	714:30	8526:33
Total % Recording Experience	96%	94%	96%	97%	99%	94%	98%	97%	99%	98%	98%	99%	97%

TABLE II
DPS Downtimes

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
Hardware Failures	04:01	02:18	00:41	03:16	02:27	14:29	01:29	03:18	03:32	04:27	01:42	00:57	42:37
Power Failures	00:18	00:05	-	-	00:17	-	00:44	00:45	01:45	00:21	00:41	01:49	06:45
System Crashes	00:52	00:52	02:10	00:52	01:37	00:43	00:25	01:13	00:44	02:03	-	03:28	14:59
Testing	18:13	26:17	10:35	01:08	00:11	13:59	08:09	04:12	02:21	-	12:01	11:37	108:43
Operational Failures	-	01:00	00:20	-	-	-	00:05	02:39	00:18	01:03	00:28	00:53	06:46
Operations	00:31	-	-	-	-	-	-	-	00:56	-	-	-	01:27
P/M	01:50	02:49	10:55	02:44	03:35	01:34	02:57	02:21	05:44	04:14	01:01	04:33	44:17
Investigating Possible Problems	-	-	-	-	00:12	00:22	-	01:16	02:31	00:11	00:13	00:12	04:57
Total Hours of Recording	718:15	686:39	719:19	736:00	663:41	712:53	706:11	728:16	702:09	731:41	727:54	696:31	8529:29
% Recording	96%	95%	96%	99%	98%	96%	98%	98%	97%	98%	98%	96%	97%

TABLE III
40B Utilization

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	%
Research	01:00	02:30	01:30	-	-	-	-	-	-	-	-	-	05:00	-
Operation Support for NEP (Mass Store)	83:00	64:00	37:00	16:00	-	-	-	-	-	-	-	-	200:00	2%
Batch Programming	23:00	37:00	11:00	-	-	-	00:30	02:30	-	-	-	02:00	76:00	1%
Operations	03:30	-	14:00	03:00	05:30	-	07:00	104:00	-	03:30	02:30	08:30	151:30	2%
DP	12:00	21:00	12:30	01:30	05:30	-	-	-	-	-	-	-	52:30	-
NEP	393:00	427:30	378:00	443:30	542:00	510:00	365:00	255:00	153:00	187:00	172:00	247:00	4073:00	52%
Data Services	00:30	03:30	-	00:30	-	03:30	-	03:30	-	-	-	-	05:30	-
Downtimes	19:30	18:30	36:00	06:30	20:00	115:00	03:00	64:00	35:00	14:30	73:30	19:30	425:00	5%
Other Downtimes	25:00	53:00	172:00	08:30	16:00	20:00	-	-	98:00	121:00	27:00	-	540:30	7%
Real-Time	-	-	23:30	18:00	07:00	41:00	210:00	190:00	404:30	451:00	396:00	289:30	2030:00	26%
Documentation	-	-	08:00	14:30	23:30	34:00	11:00	16:00	20:30	23:30	19:00	05:00	175:00	2%
VSC	-	-	-	-	-	01:00	-	-	-	-	-	-	01:00	-
Classified	-	-	-	-	-	-	-	-	-	-	-	80:00	80:00	1%
Total Hours	560:30	627:00	693:30	512:00	619:30	721:30	596:30	632:00	711:00	800:30	690:00	651:00	7815:00	

TABLE IV
Distribution of 360/44 Block Time (In Runs)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	% OF TOTAL RUNS
Systems	1090	1444	1291	1273	1199	1511	1180	1127	1104	1181	1394	1014	14808	21%
Operations	92	44	75	77	44	70	63	106	144	264	227	248	1454	2%
Data Services	1594	1561	1728	1850	997	1280	1199	1828	1609	1356	1353	1631	17986	26%
ENSCO	873	83	233	1034	1196	1598	1887	1844	1854	1165	438	323	12528	18%
VSC	27	149	206	205	142	97	97	91	170	80	130	100	1494	2%
AFOSR	-	05	45	92	93	143	280	317	103	99	40	36	1253	2%
Real-Time	123	190	159	86	108	148	62	47	09	32	42	41	1047	1%
Batch Programming	92	338	409	249	292	283	531	394	453	443	251	278	4013	6%
NEP	10	-	-	-	-	-	-	-	-	-	-	-	10	-
Documentation	49	-	-	-	25	29	04	01	01	01	03	03	116	-
NSS Evaluation	-	-	-	-	-	-	-	138	121	126	281	259	925	1%
Micro Lab	05	126	13	45	-	-	-	04	01	-	-	-	194	-
11/70 Data Retrieval	-	-	-	-	-	-	-	06	-	-	35	26	67	-
Research	819	957	1004	1098	1103	1271	1689	1466	1130	1088	804	708	13137	19%
Total Runs	4774	4897	5163	6009	5199	6430	6992	7369	6699	5835	4998	4667	69032	

TABLE V
Distribution of 360/44 Block Time (In Hours)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL HRS.	% OF TOTAL
DOS	14:30	18:30	03:30	22:00	01:00	06:00	06:30	13:00	11:00	21:30	12:30	04:00	138:30	1%
TS44	692:30	644:00	708:30	639:00	610:00	577:30	684:00	706:30	670:00	701:30	647:30	585:00	7866:00	89%
Systems	04:30	-	-	-	-	-	-	-	*00:30*	*00:30*	*00:30*	-	06:00	-
Classified	17:30	44:30	23:30	39:30	25:00	65:30	10:30	09:00	23:00	07:00	19:00	04:00	288:00	3%
VSC	-	-	-	-	-	-	-	-	-	-	-	12:00	12:00	-
Down Time	15:00	13:00	08:30	43:30	36:00	95:00	19:00	15:30	15:30	13:30	65:00	110:00	449:30	5%
Total Hours Operating	*729:00*	*707:00*	735:30	700:30	636:00	649:00	701:00	728:30	704:30	730:30	679:00	610:00	8310:30	
Percent of Total Hours Available/ Monthly	98%	98%	98%	94%	94%	87%	97%	98%	97%	98%	91%	84%	95%	

TABLE VI
ENSCO TS44 Utilization in Percent

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Averages
Wall Clock (Total)	16%	.7%	4%	15%	24%	30%	31%	28%	37%	33%	13%	10%	20.1%
CPU Time (Total)	17	.3	4	14	26	36	32	32	42	46	15	13	23.1
CPU Time (Mon-Fri)	15	.6	5	17	23	29	36	35	44	35	11	11	21.8
Wall Clock (Mon-Fri, 8-5)	14	2	7	21	29	28	40	33	41	34	14	14	23
Job Submittal	15	1	4	13	21	24	39	26	23	21	08	05	16

TABLE VII
PDP-11/70 Usage

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	PERCENT USAGE
SDAC Research	232:36	213:06	224:18	125:18	99:24	154:24	229:12	163:06	139:36	163:18	73:24	238:06	2055:48	23%
SDAC General Usage	81:18	94:48	150:48	142:24	71:48	175:24	81:00	90:24	30:24	60:06	71:24	95:12	1145:12	13%
Operations	39:54	10:48	41:24	42:30	19:24	03:30	25:00	03:30	40:36	19:00	21:30	09:48	276:48	3%
ENSCO	07:54	10:12	-	01:00	11:12	08:12	03:00	03:24	00:24	00:24	00:36	36:30	82:18	1%
Systems Programming	263:48	210:18	235:24	166:12	302:30	262:06	528:12	380:42	233:12	646:54	566:00	312:12	4107:30	45%
Realtime Programming	-	-	-	-	-	-	-	-	32:00	300:12	173:24	236:06	741:42	8%
NSS Development	-	-	-	-	70:30	91:40	31:00	118:30	51:18	69:24	21:06	-	453:42	5%
VSC	-	-	25:06	24:24	25:12	12:06	01:30	04:06	00:06	01:06	12:42	04:36	110:54	1%
Lincoln Labs	-	01:06	00:06	-	-	-	-	-	-	-	-	-	01:12	-
Documentation	-	-	-	-	-	-	-	-	75:06	07:18	-	-	82:24	1%

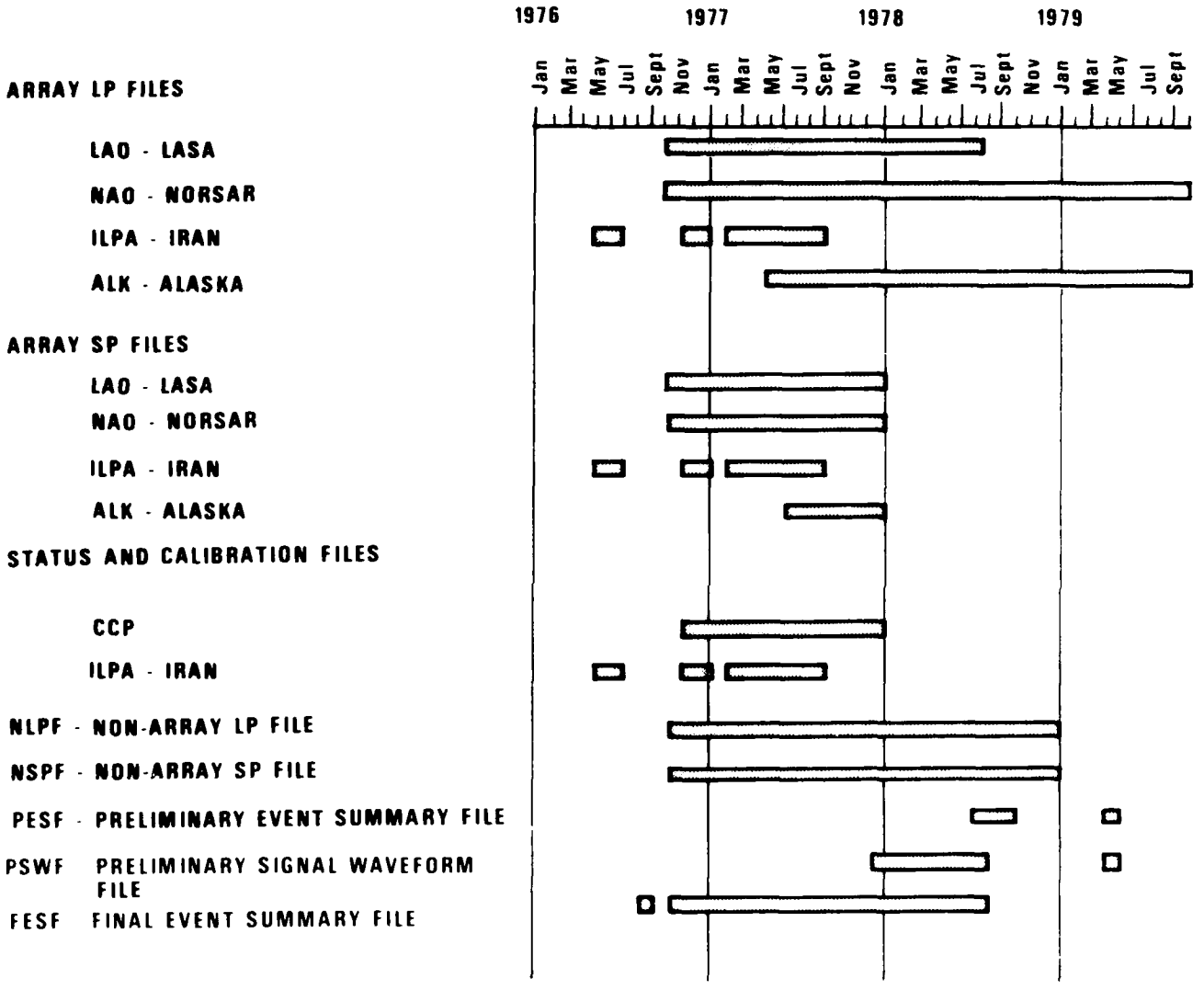


Figure 4. VELANET Data Files Sent to the Mass Store

III. PROGRAMMING

The programming effort was directed primarily toward maintaining the operational status of the Communication and Control Processor (CCP), the Detection Processing System (DPS), and the Network Event Processor (NEP). Programming support was also provided to Data Services, ENSCO, and VSC using the IBM 360/44 and the PDP-15/50.

In general, the programming consisted of maintaining existing systems rather than producing any major new program or other software capability. Many improvements, corrections, and enhancements were made to all systems. Changing data sources and input configurations also required system support and program modifications.

The following sections summarize the significant programming accomplished on the various systems.

Communications and Control Processor (CCP)

The CCP was operated continuously during the contract period. It supplied the Seismic Input Processor (SIP) at CCA and the DPS with continuous seismic data for recording and processing. Using this system our operations staff was able to monitor the data flowing into the SDAC and maintain records concerning reliability and availability of the real time data. The operation of this system was interrupted only for hardware malfunctions and development effort.

Program version 155 was running at the beginning of the contract. Version 214 was implemented at the end and it reflected numerous changes and improvements.

The most significant changes were to: accommodate a SRO data channel from Albuquerque, New Mexico, which was added to the data stream from the Pinedale, Wyoming site; remove all code referencing LASA from the system to simplify the program and gain processor speed and memory; and format NORSAR data for the HDT at PAFB and transmit it in real time to the system. Other changes were made to accommodate data from the National Seismic Station (NSS) prototype system. The effort relating to the CCP to accept NSS data is given in Chapter VI.

A summary of the changes and improvements that were made to the CCP are as follows:

- Parameters were modified to accept data from the SRO site.
- Transmission protocol of data block headers was modified so that they would not span message boundaries.
- Protocol and code was added to transmit NORSAR EPX and SEISMO data (input from the 360/44) to PAFB. (Code and protocol defined).
- A new operator command 'RESET' was added to clear the PAFB communication path.
- All code referencing LASA was removed.
- The problem with intermittent halts was fixed.
- A two bit shift to the real time NORSAR data sent to PAFB was implemented.
- Changes to the Alaskan channel configuration were made.
- The VELANET protocol to the DPS was improved.
- A correction was made to prevent the seven-second time gap which was occurring hourly.
- Load time default values were changed to reduce CCP statistical printouts.
- Task priorities were improved. The Pseudo Interrupt Devices (PID) levels for the Host Line Interface (HLC) and Real Time Clock (RTC) cards were changed to support the new priorities.
- Initialization of the PAFB Buffered Serial Line Interface (BSLI) was changed to provide better service during start up.
- Three Alaskan long period data channel names were changed to reflect the shift from site "C" to site "D" at ALK.
- A correction to subroutine TODCHK was made to prevent random alterations of the system timing.
- The communication status of the data sites code was changed to display the status on the console lights.
- A debugging tool on the 40A for the CCP was developed to validate protocols and record data sent from the CCP.

Detection Processing System (DPS-360/40A)

The DPS completes the real time environment of our systems. It also functioned continuously during the contract period recording all of the real time seismic data and performing a detection algorithm on selected channels.

The system was primarily used to perform experiments to determine ways of improving the detection capability. The significant improvements or experiments performed on it were:

- o Deglitching algorithms and reinitialization tests were conducted.
- o The Albuquerque SP channel was added to the system for recording and detecting.
- o The tape I/O error software was corrected to handle high volume error rates.
- o MOD cards were eliminated from the parameter deck.
- o Scaling factors for all detecting channels were finialized.
- o The source code was updated to coincide with the changes implemented with MOD cards.
- o The NSS data were incorporated and the detection algorithm was implemented on the 20 S/S NSS channel.
- o An RIT detection parameter test was conducted and new parameter values were established.

Numerous tests and analysis of the data output from this system revealed that erroneous detections were being made and that obvious signals were not being detected. Investigation into these malfunctions continued at the conclusion of the contract period.

Network Event Processor (NEP-360/40B)

The 360/40B was used primarily to produce the seismic bulletin. Inputs for this processing were the detection list created by the DPS, the waveforms recorded by the DPS, and other arrival and detection lists provided by other

government agencies and countries.

New capabilities were added to this system during the term of the contract. The most significant of these was the ability for NEP to apply discrimination algorithms to waveform data selected by the analyst. The ability to predict LP travel time and compute M_S was also implemented. Other new capabilities and corrections were for the Automatic Association system.

Improvements and enhancements were made and many errors were corrected. A summary of this effort follows:

- Code for using the 2260 was taken out of the program that transferred data from the 11/35 to the 360.
- The AA program was modified to accept external event data.
- The PL360 I/O software was removed to decrease the size of the root phase in NEP.
- An overflow error was corrected which appeared during LP processing.
- The mass store creation program was modified to predict arrival times from selected stations.
- The Waveform Segment File (WSF) was implemented. Data that can be input to the WSF include NORSAR EPX and the standard SUBSET waveform data.
- The AMP/PER calculation was modified to use the last tabulated entry in the response curve file when the period values exceed either end of the table.
- The AA program was modified to permit using any of the ALK sites as a primary site to initiate event formulation.
- An error was corrected in the focal sphere display.
- The graphics task system was modified to permit using only one of the cartridge disks.
- The program NEISBLTN was modified to accept data from the seismic arrays WRA and GBA.

Other activities performed on the system was the preparation of specifications to implement rotation and LP beaming.

Batch Processor (IBM 360/44)

The 360/44 is used in a batch environment to support the scientific users in their research efforts and to support the real time system in quality control and data handling. Another major use of the system is to prepare data sets and files to satisfy data services requests.

The activities to support the operations of the system on the 360/44 are summarized below:

- An error was corrected in the DOS tape library maintenance program.
- The library tape maintenance program was modified to correct intermittent program aborts.
- A support utility was created to allow users to punch programs from disk without requiring the use of temporary tapes.
- A support program to list disk use by user was written.
- TELENET, a program to print the ASCII tapes created by the IBM 360/40B - PDP-11/35 transfer, was written.
- Two tape drives were moved from the DPS system to the TS44 system and changes to the system software were made.
- The TS operating system was modified to alter selection priorities during tape drive access.
- The socket display subsystem was rewritten.
- The file archive routine MULTIFIL was modified so that a user's entire directory is archived by using a single command.
- TS44 "Help Files" were reviewed and updated as required.
- The SUBMIT subsystem of TS44 was modified to allow users to print the content of the TS44SOR.DOCUMENT disk directory.
- Several errors were corrected in the Network Control Program (NCP).

Programming support was provided to researchers and data services. The programs and the changes or modifications made to them are:

DEGR - Written to degainrange data values.

DPBEAM - Modified to:

- o process channel calibration data input from cards
- o correct random end-of-files on the card reader
- o print input values for despiking thresholds
- o allow extraction of the NSS data from the DPS data tape
- o enable processing the fourteenth short-period data channel of the Wyoming site (ALQ SRO)

DPCOPY - Written to copy DPS tapes without extensive error recovery procedures.

DPSMRG - Reads up to four tapes in an intermediate format and creates a single DPS output tape.

DUPCHK - Written to QC the output tapes created from the SRODUP program.

FOOBAR - Inputs either SDCS or SRO tapes and creates an intermediate format tape to be input to DPSMRG.

GAINR - Written to gain range data values.

HYPO71 - Modified to accept 72 character input strings from terminals. The format of the parameters input to the program was also changed.

ILPA - Written to process post May 1978 ILPA tapes.

LOC - A hypocenter determination routine obtained from MIT, has been converted to run on TS44.

M7A - Modified to allow handling post November 1977 NORSAR short period data.

NEWQC - Modified to:

- o correct a problem in time-gap reporting
- o handle the new data from NSS
- o perform more rigorous checks of the individual sites data times
- o produce a delog listing of the NORSAR EPX records on the DPS tape and to identify AI events
- o correct logic errors in the statistics tape punch section and to bypass bad NORSAR EPX records

The following programs were catalogued in the TS44 libraries:

COMMERGE	MULTIFIL	OCDUMP	SRO2DP
DPBEAM	MULTISPY	REFLX	SURVEY
DPBEAMX	NEWMGR	SCARS	TIBURY
FIT4	NEWPLOT	SCARSX	TIKSPED
FLINE	NEWQC	SCARS4	TILIPABF
ILPA	NSSBEAM	SMOOT	TISSDP
LISTATCO	PARSER	SROCOPY	TISSPROG

Interactive Processor (DEC PDP-15/50)

Minimal effort was spent on this system during this contract period. The system was used for some minor demonstrations, support data services in QC functions, and perform A/D conversions. Programming support consisted of using system utilities to dump tapes and perform system maintenance functions.

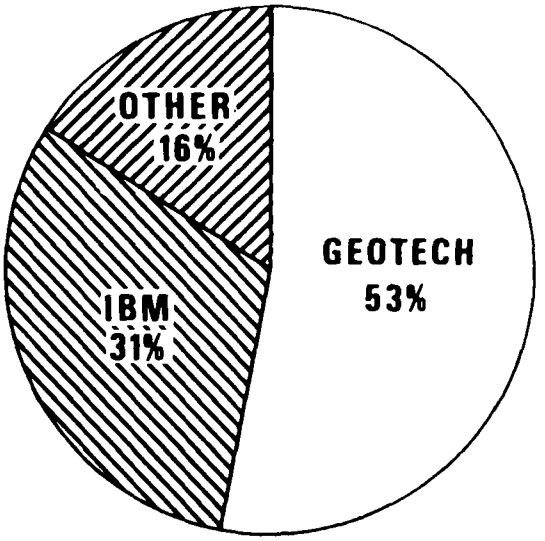
IV. MAINTENANCE

The computer systems and other equipment at the SDAC are maintained by Geotech personnel and contractors. During this contract period Geotech personnel maintained the Communication Control Processor (CCP), timing systems, modems, and ARPANET interfaces associated with the real time data collection and monitoring systems. The NEP graphics system was also maintained by Geotech personnel. It includes a PDP-11/35 computer, an Evans and Sutherland graphics display device, a hardcopy unit, an Ann Arbor alpha-numeric terminal, two Pertec Disk Drives, and an interface to the 360/40. Other computer systems and/or peripherals maintained by Geotech personnel include the PDP-15/50 and all of its peripheral devices, the incremental plotters, some of the terminals at the facility, and peripherals on the PDP-11/70 which include four Kennedy tape drives, the Pertec disk 192KW of core memory, and the Versatec printer plotter. Other equipment maintained by Geotech include filters, tape drives, test equipment, A/D conversion components in the analog laboratory, the tape evaluator, numerous film viewers, and reproduction equipment throughout the laboratory.

Contract maintenance was obtained from the suppliers of the equipment shown:

Supplier	Equipment
IBM	Two 360/40's and the 360/44
FABRITEC	360/40B Memory
DEC	11/70
MEMOREX	Disk drives (5 on the 360/40B)
CALCOMP	Disk drives (5 on the 360/44)
CDI	Terminals
WILLIARD	Air-Conditioners
MISC	After hours, maintenance and Calibrations

The cost distribution for the maintenance is:



The general condition of the hardware of the major systems maintained by Geotech staff is summarized in the following sections.

CCP

Most of the maintenance of this system was related to the output devices. The hardcopy terminals required cleaning and replacement of print heads. The CRT of the Tektronix display unit was replaced.

In general the electronic portions of the system performed satisfactorily, only two component boards were repaired during the year.

The equipment procured during VT/8709 for the OFF-LINE-CCP project was delivered and assembled during the term of this contract. With the off-line system, we were able to repair and return to inventory several defective circuit cards from the on-line CCP.

A considerable amount of time was also spent training SDAC maintenance personnel in the maintenance of the system and in the use of special hardware diagnostic routines.

PDP-11/35

Nearly all of the maintenance for this system was the repair of the cartridge disk drives.

At the beginning of the contract period a diagnostic program was developed in an effort to correct the problem of an occasional program loop developing during the exchange of data between the 360/40B and 11/35. The diagnostic provided some insight into the problem and some minor corrections were made to the hardware. Other corrections in the hardware were implemented but the problem still remains.

PDP-15/50

Routine maintenance was performed on nearly all components of the system. Although considerable effort was expended on the equipment, no single peripheral or component caused unusual or extended problems.

PDP-11/70

Three tape drives and 64K bytes of memory were installed during the contract period.

The most noticeable failure of this system was the large 88 megabyte disk. Although this device is under contract maintenance, repairs were lengthy because of slow delivery of parts and apparent lack of familiarity with the equipment on the part of DEC service personnel.

Terminals

Routine repairs and cleaning of these mechanical devices were made during the course of the contract period. There were no unusual or extensive problems with any particular device.

Plotters

These devices also required routine repairs and cleaning. Because of their age, the repairs were frequent and often required spares no longer inventoried by the vendor, thus adding to the cost and extending down time.

Analog

Repairs were made to filters and the time-code-reader.

General

Cleaning and inspection of the numerous film viewers were conducted throughout the year. Bearings were replaced on some of the units.

Other equipment requiring some attention includes test equipment, the tape cleaner/evaluator, and data reproduction devices.

The air-conditioners are all under contract maintenance. They required considerable maintenance, primarily because of their age; however, no significant down time occurred on any of the systems because of air-conditioning failure.

An extensive problem occurred on the IBM-360/44 during the latter part of the contract. After several weeks of investigation by IBM, it was determined that the wiring of the main power coming into the room was not done according to recommended IBM standards. Although no corrective action was taken, the intermittent failure did not reoccur.

Table VIII provides statistics concerning the maintenance performed by Geotech personnel during the contract period. These time figures reflect only time spent in preventive maintenance and repair and do not include duties such as parts ordering, design, planning, and supervision conducted by Geotech personnel.

TABLE VIII
Yearly Summary of Maintenance Activities/System

	OCT		NOV		DEC		JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		TOTALS	
SYSTEM	PM	REP	PM	REP	PM	REP	PM	REP	PM	REP	PM	REP	PM	REP	PM	REP	PM	REP	PM	REP	PM	REP	PM	REP	PM	REP
CCP	3	7	2	12	2	10	4	0	4	2	2	4	2	6	2	0	2	1	2	3	2	0	2	2	29	47
PDP-11/35	8	4	4	0	4	6	4	3	4	10	4	0	4	0	4	7	4	1	4	11	4	40	4	0	52	82
E&S	8	6	4	20	4	9	4	5	4	2	4	0	4	8	4	0	4	0	4	7	4	0	4	6	52	63
PDP-15/50	8	17	8	20	8	10	8	21	8	13	0	33	8	17	8	26	8	6	8	6	8	16	8	0	88	185
PDP-11/70	0	0	0	2	2	0	2	32	0	5	See note 1		0	3	See Note 2		See Note 2		2	0	See Note 3		0	24	6	66
TERMINALS	0	3	0	4	0	1	0	4	0	4	0	0	2	3	2	0	2	0	2	8	2	0	0	30	10	57
PLOTTERS	4	4	8	2	8	0	8	0	8	0	8	0	0	0	4	5	2	0	2	0	0	0	2	2	54	13
ANALOG	0	0	8	0	8	5	8	8	8	5	0	0	8	0	8	4	8	0	8	0	8	16	8	20	80	58
GENERAL	0	16	0	12	0	0	0	3	0	0	0	6	0	0	10	0	1	0	6	0	0	0	0	3	17	40
TOTALS	31	57	34	72	36	41	38	76	36	41	18	43	28	37	42	42	31	8	38	35	28	72	28	87	388	611

Note 1. The system was down from 23 March to 28 March because of disk related failures. The extensive time was to obtain parts and find personnel more familiar with the equipment.

Note 2. Trouble reported to DEC field service personnel on 31 May, system repaired on 5 June.

Note 3. DEC field service personnel worked on the terminal interface.

V. DATA SERVICES

One of the primary functions of the SDAC is to provide data and computer services to the seismic community engaged in the VELA effort either directly or through basic research.

This support usually consists of producing a requested data set from the various libraries at the SDAC. The seismic data libraries are in the form of film, and analog and digital tape. Requests are usually satisfied in digital form but paper plots, or film copies are also available. Numerous formats and various configurations of the seismic stations require a considerable quality control and recordkeeping effort.

The bulk of the data is obtained for VSC sponsored projects supported by several contractors, or for AFTAC internal use; however, many agencies, institutions and contractors, both domestic and foreign, request and receive data. During the period of this contract the following solicited data from the SDAC:

AFTAC/TGS
Albuquerque Seismological Laboratory
California Institute of Technology
Cornell University
Hanyang University, Korea
Institute for National Defense, Sweden
Institute of Geological Sciences, Edinburgh
Instituto di Fisica Guglielmo Marconi, Rome
Instituto Nacional de Meterologia Geofisica, Portugal
Lawrence Livermore Laboratory
Lincoln Laboratories
Los Alamos Scientific Laboratory
National Defence Research Institute, Stockholm
NORSAR
Osservatorio Vesuviano, Italy
Pennsylvania State University
Scripps Institute
Sierra Geophysics
Southern Methodist University
St. Louis University
Systems, Science, and Software
Teledyne Geotech, Garland
Tennessee Valley Authority
Universita Degli Studi, Italy
United States Geological Survey, Albuquerque
University of Alaska
University of Arizona
University of California, Berkeley
University of Cambridge, England

University of Michigan
University of Nevada, Reno
University of Southern California
University of Sydney, Australia
University of Texas, Galveston
University of Washington, Seattle
University of Wellington, New Zealand
Weston Observatory
World Data Center

One of the major data resources at the SDAC is the analog tape library. It consists of LRSM data recorded between 1961 and 1970, and data from the Geneva Observatories and TFO. A wide variety of experiments were conducted during this contract period using one or more of these sites. A function of Data Services is to provide the A/D conversion of these data. This involves scheduling requests through the conversion process, quality control of the output, and making the output data available to the user as a digital tape in the SDAC tape library. During the year 428 completed A/D requests were processed, not including about 100 requests to recover data from stations HNME and RKON, as part of data set requests.

Three major data sets were prepared during the year. The task is to recover all available waveform data for seismic events that fulfill a location criteria. Two of these sets, completed early in 1979, contained about 340 events. The third contained 12 events from a specific area. By the end of the year 10 of the events were processed, two of the events were partially recovered.

SRO/ASRO Day Tapes continued to be made. This data consists of a 26 hour data frame for each station beginning at 0000 hours and ending at 0200 hours on the following day. The SRO/ASRO stations in this data set are, ANMO, ANTO, BOCO, CHTO, GUMO, NWAO, GRFO, SHIO, TATO, SNZO, CTAO, ZOBO, KAAO, MAJO, and KONO. There are periodic operational interruptions. Thus a particular day tape may not contain all sites.

Table IX is a tabulation and quantity of the various categories of tapes that are stored in the facility.

TABLE IX

Tape Library Inventory

On 30 Sep 1979 the tape library contained the following tapes;

Digital Archives

Data Set		122
LASA Event		563
NORSAR Event		234
Long Period (LASA, ALPA, and NORSAR)		5639
SRO Field		173
SRO/DAY		2255
HGLP Field		360
Extended Long Period		1250
ILPA MERGE		172
Short Period Events 1965-1969		134
Short Period LASA		6675
LASA Multiplexed		960
LASA 1975 Recorded at Billings		3000
DPS		6417
Short Period NORSAR		1200
LASA Copy Tapes		91
Detection Log (ISM)		31
Korean Event Processor Tapes		4644
ALA Processor Tapes		1241
UBO Long Period		33
TFO Long Period (BGR)		3
A/D Conversions (LRSM and SDCS)		1136
D/D Conversions (LASA)		894
SDCS		3565
SDCS Event Subset		46
Permanent Hold Tapes CDC 1604 Operations		501
Library Control Tapes		15
DOS		71
ILPA		486
A/D Count		95
	sub total	42006

Digital Tapes (to be recycled)

Individual Users		2102
Scratch Tapes		1019
EP-DP Tapes		261
DPS		66
System Backups		413
	sub total	3861

Analog Tapes

Compressed Tapes		8779
Composite Tapes		509
Tapes as recorded (0.3 ips)		16566
Tapes to be compressed		4810
Special Data Collection System Tapes		518
	sub total	31182
	Total	77049

VI. SDAC DATA MANAGEMENT RESEARCH

The effort for this task was directed toward further development of the PDP-11/70 system and a microprocessor-based system to accept data from a seismic station being developed to acquire regional data. The following sections provide an overview of specific accomplishments related to the development of the PDP-11/70 system and the final configuration and status of the system to accept regional seismic data.

Data Retrieval and Analysis System (PDP-11/70)

This system was acquired and installed during the previous two contracts (VT/7709 and VT/8709). Its intended use is to support the activities of data services. The capabilities to be developed are to accept waveform data from numerous sources and varying formats and to develop a uniform data base upon which standard functions can be performed such as:

- o producing graphic and hardcopy plots;
- o allowing vertical and horizontal scaling of waveforms;
- o automatically logging or filing time picks;
- o automatically logging and filing amplitude measurements;
- o allowing trace movement and/or scrolling; and
- o having seismic utilities to predict arrival times and calculate travel times.

Developing the system in this framework will facilitate quality control functions, provide an environment for multiple users, permit research activities and allow augumentation of the system.

During the year there were many program utilities developed, improvements were made to the system, and errors corrected in both system and application software. This effort provided the following capabilities:

- o ARPANET message facility was added.
- o System accounting was upgraded to maintain a record of users accessing the system directly or from the network.
- o A library maintenance routine was written to cross reference and sort program library entries.
- o File access mechanisms were modified to enable graphic output from FORTRAN programs.

- o A line printer driver was written for the Versatec.
- o A command was modified to allow removing all of the files in a directory.
- o Several commands were modified to include error information in their parameters.
- o The NECwriter was installed and support software written.
- o A command was corrected to prevent directory linking.
- o An error was corrected in the "C" compiler that dealt with long integer specifications.
- o Two new tape drives were installed and the corresponding system updates were made.
- o A program to read SUBSET tapes was written.
- o An editor developed at Berkeley was installed.
- o A program to read DPS tapes and write to the waveform data base was written.
- o A program to write SUBSET tapes from the waveform data base was written.
- o A program was written for the 11/70 that is similar to the INTAPE routine on the 360/44. This routine reads magnetic tape.
- o A bug in the Versatec handler was corrected.
- o A system utility was developed to maintain program libraries.
- o A utility routine to convert EBCDIC to ASCII was written.
- o A utility routine to convert 360 floating point to PDP-11 floating point was written.
- o Errors in the F77 FORTRAN compiler were corrected.

Sandia Prototype Seismic Station Data

The previous contract, VT/8709, was amended to develop hardware and software to receive, record, and process data from a prototype system developed by the Sandia Corporation for use in a CTBT environment. These systems will be capable of gathering seismic data for small events at regional distances. They will operate unattended and transmit seismic data to satellite to be relayed to a central headquarters for recording and analysis.

The prototype system of one site had 10 channels of data. One high frequency channel of a vertical instrument sampled at 60 samples per second, three short period channels of one vertical and two horizontal components each sampled at 20 times per second, three medium period channels with one vertical and two horizontal components each sampled at four samples per second, and finally three long period channels again consisting of one vertical and two horizontal components being sampled once per second.

To protect against data loss and increase security, these data are transmitted twice with about a 15 minute delay between the transmissions. Consequently the resulting data stream consists of a bit interleaved ontime real-time data stream and a 15 minute delayed data stream also in real-time.

Phase I of the SDAC project was to receive and record only the real-time data stream and process the three SP and three LP data channels through NEP. This work was accomplished during VT/8709 (FY'78).

Phase II was to process the delayed data stream by displaying it on the CCP and recording it on tape. Also, analysis was to be performed on the high frequency and mid-period data and the results of the data transmitted to the Mass Store with other data routinely processed by NEP.

Most of the hardware was obtained during the previous contract. Figure 5 is provided to show the major components of the system and the functions each of them perform. The new hardware is called the Regional Station Input (RSI) system. The three major components consist of SYNC, GPII, and MAIN modules. The SYNC module establishes communication synchronization with the two incoming data streams and splits the data stream into the real-time and delayed components. The GPII (General Purpose Intelligent Interface) reorders the data within a given time frame to conventions established in the VELANET. The MAIN module converts data sample values from Sandia formats to VELANET formats.

The effort placed in the RSI in support of this contract consisted of software modifications to handle the delayed data stream. The design and implementation of these modifications were completed. During system testing several problems arose with regard to bit inversions and the generation of the data time.

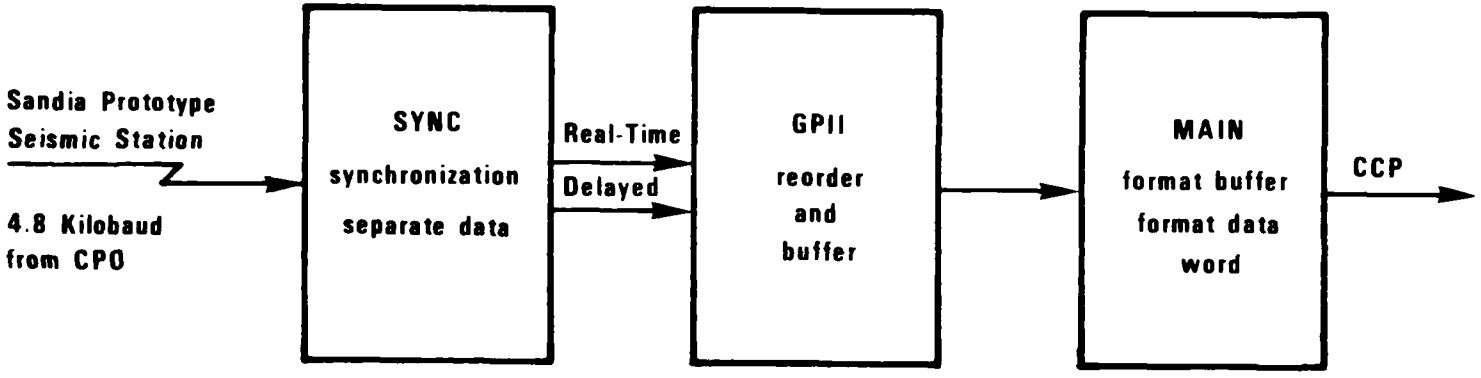


Figure 5. Regional Station Input System

Considerable modifications were made to the CCP to incorporate this new data source. The extensive modifications were necessary because of the new sampling rates of 60 and four samples per second. The changes involved restructuring tables and modifying the various programs accessing them.

The DPS required changes only to parameters and tables. No consideration was made to detect on any channel other than the SP vertical. This task was sufficiently similar to the other processing functions that only these minor changes were necessary.

NEP and the programs that support it were evaluated in detail to determine if the 60 and four sample per second data could be handled effectively. Because of hardware constraints, buffer sizes, and the format selected for the time value, the HF and MP data were not evaluated geophysically using NEP. However, the programs to send the data to the Mass Store were modified to include the Sandia data should modifications to the NEP be incorporated.

An evaluation of this system was performed. It considered both the SDAC hardware/software aspects as well as the geophysical conclusions. The report was published under project VT/9709; a portion of the abstract follows:

EVALUATION OF THE NATIONAL SEISMIC STATION
(SDAC-TR-79-8)

The resolution in A/D conversion when recording waveforms of night-time (low) noise on four different NSS channels at CPO is 0.3 to 1% of the RMS noise power. Clipping of the middle period (MP) and long period (LP) channels in A/D conversion was observed in case of an M_S = 7.6 shock at distance 22°, and signal amplitudes up to 30% of the clipping level have been observed on the short-period channel when recording non-destructive local shocks (up to 1°).

SNR computations suggest that regional phases (P or L_g) can be easily detected above 5 Hz; Lg waves from an NTS shot at distance 22° had their maximum SNR at the period of 4 seconds. P-waves from teleseismic events generally had SNR maxima at 1 Hz, poor SNR > 5 Hz, and a deep minimum around periods of 4-5 seconds.

Also discussed in this evaluation is the data link format and communications preprocessing. There were several problem areas primarily with time code procedures in the NSS site design.

VII. CONTROLLED OPERATIONS

The area containing the communication and recording computers, the Network Event Processing system, the PDP-11/70, the tape library, conference room, maintenance, keypunch room, and the access area was converted to a controlled area. Figure 5 shows the previously controlled area as being lightly shaded. The expanded area is shown as being darkly shaded.

This task involved constructing a barrier by extending several of the walls to the roof. Two normal entrances were established with cypher locks and a third entrance, necessary as a fire escape, was equipped with an alarm system. These details are also shown in Figure 6.

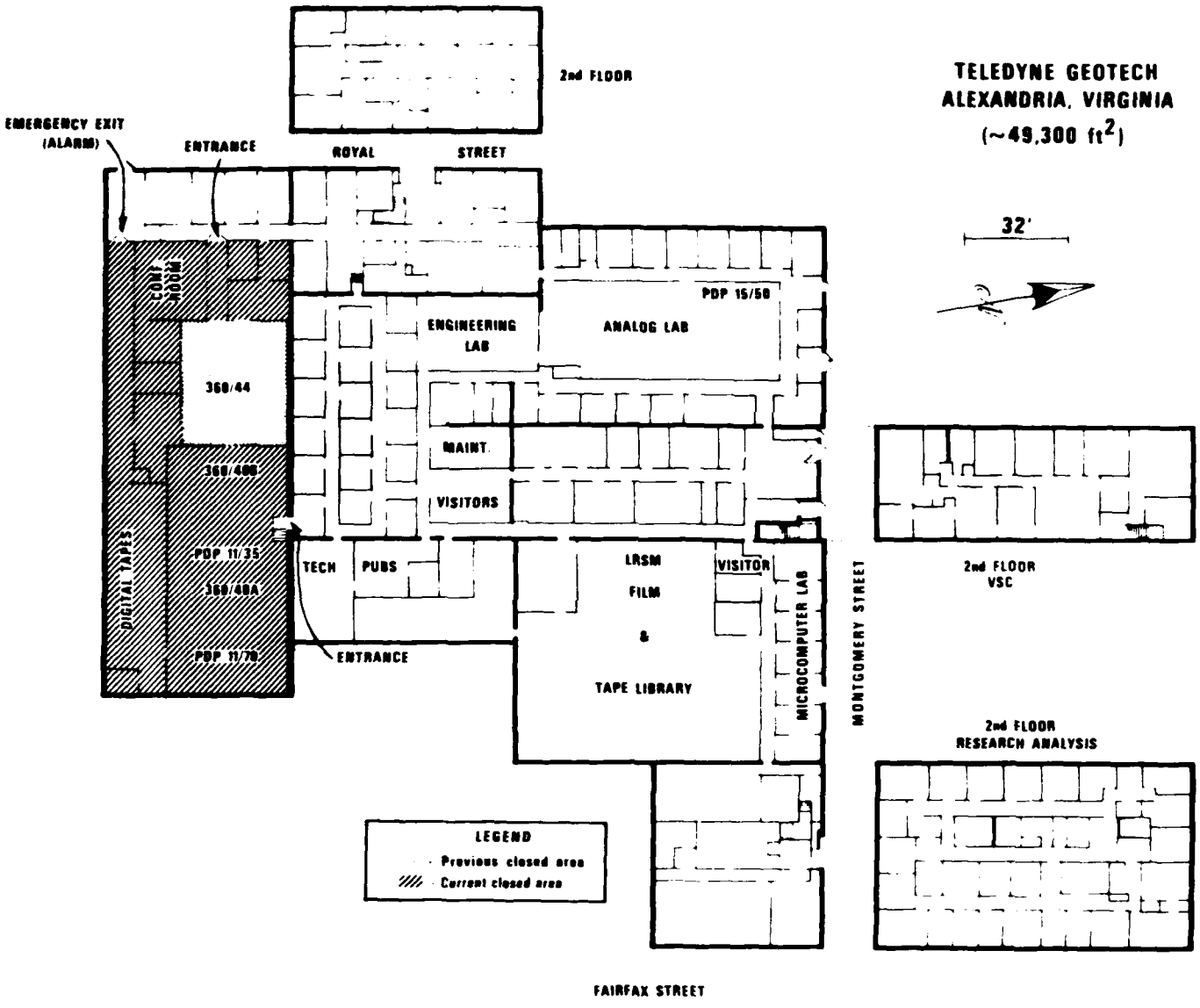


Figure 6. Controlled Area

VIII. A/D EQUIPMENT

Toward the end of the contract a Kinemetrics digital recording system was furnished by the government to accomplish analog to digital conversions. The Kinemetrics unit was originally acquired for the Special Data Collection System (SDCS) and sent to SDAC at the conclusion of the project.

The purpose of the SDCS was to digitally record seismic data in the field and send the resulting tapes in for analysis. In this type of operation, the hardware and recording requirements are reasonably well defined and remain static during the systems operation. Consequently, the hardware is configured to run continuously at a given sampling rate, fixed number of channels, and recording format.

The hardware modifications to the system consisted of:

- o changing the recording format to allow for identification of the seismogram,
- o obtaining the sampling rate from an external and adjustable clock, and
- o increasing the number of input channels from eight to sixteen.

The tape format this system produces is not compatible with out standard SUBSET. Software effort consisted of writing a program to read the Kinemetrics tape and write a tape in SUBSET format.